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SOLAR/1010-79/02

Monthly Performance Report

A-FRAME

FEBRUARY 1979

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U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

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MONTHLY PERFORMANCE REPORT

A-FRAME INDUSTRIES

FEBRUARY 1979

I. SYSTEM DESCRIPTION

The A-Frame Industries site is a single-family residence in Kaneohe, Hawaii. Solar energy is used for heating domestic hot water (DHW). The solar energy system has an array of flat-plate collectors with a gross area of 77 square feet. The array faces 10 degrees east of south at an angle of 21 degrees to the horizontal. Potable water is the transfer medium that delivers solar energy from the collector array to storage and to the DHW load. Solar heated water is stored in a 120-gallon DHW tank. The tank has no freeze protection. Unheated city water is fed directly to the DHW storage tank and supplied, on demand, to the DHW load. When solar energy is insufficient to satisfy the DHW load, an electrical heating element in the storage tank provides auxiliary energy for water heating. The system, shown schematically in Figure 1, has only one mode of solar operation.

Mode 1 - Collector-to-Storage: This mode activates when the temperature of the outlet of the collector exceeds that of the storage tank by 5°F. Water then circulates through the collectors until the temperature difference is 2°F or less.

II. PERFORMANCE EVALUATION

INTRODUCTION

The site was occupied during the month of February and the solar energy system operated continuously throughout the month. Solar energy satisfied 83 percent of the DHW requirements. The solar energy system provided electrical energy savings of 0.47 million Btu.

WEATHER CONDITIONS

During the month, total incident solar energy on the collector array was 2.1 million Btu for a daily average of 957 Btu per square foot. This was below the estimated average daily solar radiation for this geographical area during February of 1605 Btu per square foot for a plane facing 10 degrees east of south with a tilt of 21 degrees to the horizontal. The average ambient temperature during February was 70°F as compared with the long-term average for February of 72°F.

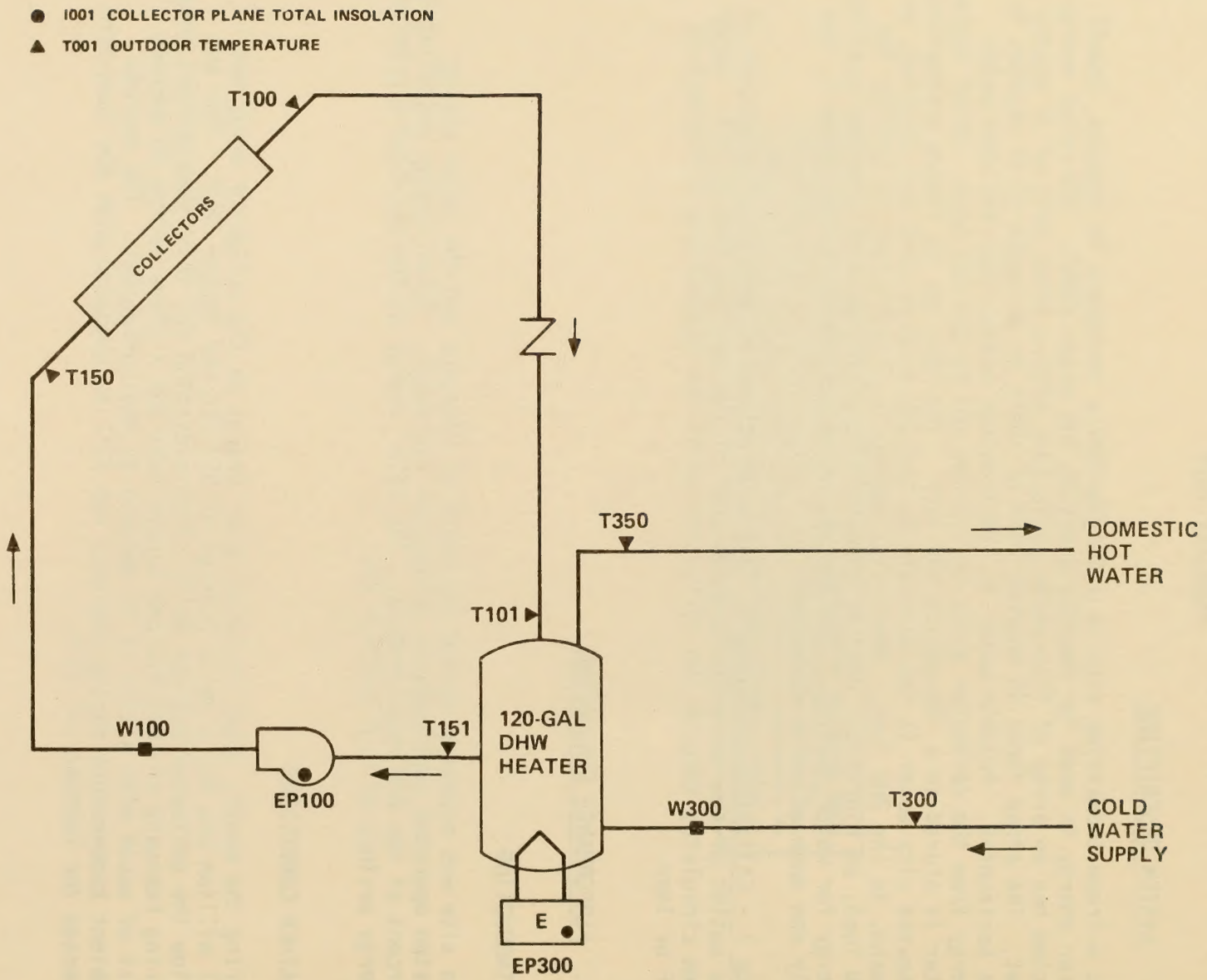

Figure 1. A-FRAME INDUSTRIES SOLAR ENERGY SYSTEM SCHEMATIC

THERMAL PERFORMANCE

System - During February the solar energy system performed as expected. The expected performance was determined from a modified f-chart analysis using measured weather and subsystem loads as inputs. Solar energy collected was 0.53 million Btu versus an estimated 0.53 million Btu. Solar energy used by the system was estimated by assuming that all energy collected would be applied to the load. Actual solar energy used was 0.52 million Btu. System total solar fraction was 62 percent versus an estimated 63 percent.

Collector - The total incident solar radiation on the collector array for the month of February was 2.1 million Btu. During the period the collector loop was operating, the total insolation amounted to 1.7 million Btu. The total collected solar energy for the month of February was 0.53 million Btu, resulting in a collector array efficiency of 26 percent, based on total incident insolation. Solar energy delivered from the collector array to the DHW subsystem was 0.52 million Btu. Energy loss during transfer from the collector array to the DHW subsystem was 0.014 million Btu. This loss represented 3 percent of the energy collected. Operating energy required by the collector loop was 0.052 million Btu.

DHW Load - The DHW subsystem consumed 0.52 million Btu of solar energy and 0.32 million Btu of auxiliary electrical energy to satisfy a hot water load of 0.55 million Btu. The solar fraction of this load was 62 percent. Losses from the DHW subsystem were 0.29 million Btu. The DHW subsystem consumed no operating energy, resulting in an electrical energy savings of 0.52 million Btu. A daily average of 51 gallons of DHW was consumed at an average temperature of 116°F delivered from the tank.

OBSERVATIONS

Moderate and intermittent data losses continued during February.

ENERGY SAVINGS

The solar energy system provided a net electrical energy savings of 0.47 million Btu. The DHW subsystem provided an electrical energy savings of 0.52 million Btu.

III. ACTION STATUS

IBM/Boeing will visit the site to resolve the data transmission problem.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: A-FRAME
REPORT PERIOD: FEBRUARY,1979

SOLAR/1010-79/02

SITE/SYSTEM DESCRIPTION:
THE A-FRAME SITE IS A SINGLE STORY FAMILY RESIDENCE. THE SOLAR SYSTEM SUPPLIES ENERGY FOR DOMESTIC HOT WATER ONLY, UTILIZING ONE 120 GAL. WATER STORAGE TANK FOR BOTH ECSS STORAGE AND DHW TANK. LIQUID TYPE COLLECTORS ARE USED WITH AN OVERALL AREA OF 77 SQ. FT. AUXILIARY HEAT FOR THE DHW IS PROVIDED BY ELECTRIC HEATER ELEMENTS.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	2.052	MILLION BTU
	26787	BTU/SQ.FT.
COLLECTED SOLAR ENERGY	0.533	MILLION BTU
	6962	BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	70	DEGREES F
AVERAGE BUILDING TEMPERATURE	N.A.	DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.25	
ECSS OPERATING ENERGY	0.052	MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	0.052	MILLION BTU
TOTAL ENERGY CONSUMED	0.908	MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL	
LOAD	0.569	N.A.	N.A.	0.569	MILLION BTU
SOLAR FRACTION	83	N.A.	N.A.	83	PERCENT
SOLAR ENERGY USED	0.519	N.A.	N.A.	0.519	MILLION BTU
OPERATING ENERGY	N.A.	N.A.	N.A.	0.052	MILLION BTU
AUX. THERMAL ENERGY	0.323	N.A.	N.A.	0.323	MILLION BTU
AUX. ELECTRIC FUEL	0.323	N.A.	N.A.	0.323	MILLION BTU
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A.	MILLION BTU
ELECTRICAL SAVINGS	0.519	N.A.	N.A.	0.467	MILLION BTU
FOSSIL SAVINGS	N.A.	N.A.	N.A.	N.A.	MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.456

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: A-FRAME
REPORT PERIOD: FEBRUARY,1979

SOLAR/1010-79/02

SITE/SYSTEM DESCRIPTION:
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GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	2.165 GIGA JOULES
	304190 KJ/SQ.M.
COLLECTED SOLAR ENERGY	0.563 GIGA JOULES
	79065 KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	21 DEGREES C
AVERAGE BUILDING TEMPERATURE	N.A. DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.25
ECSS OPERATING ENERGY	0.055 GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	0.055 GIGA JOULES
TOTAL ENERGY CONSUMED	0.958 GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	0.601	N.A.	N.A.	0.601 GIGA JOULES
SOLAR FRACTION	83	N.A.	N.A.	83 PERCENT
SOLAR ENERGY USED	0.548	N.A.	N.A.	0.548 GIGA JOULES
OPERATING ENERGY	N.A.	N.A.	N.A.	0.055 GIGA JOULES
AUX. THERMAL ENG	0.341	N.A.	N.A.	0.341 GIGA JOULES
AUX. ELECTRIC FUEL	0.341	N.A.	N.A.	0.341 GIGA JOULES
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A. GIGA JOULES
ELECTRICAL SAVINGS	0.548	N.A.	N.A.	0.493 GIGA JOULES
FOSSIL SAVINGS	N.A.	N.A.	N.A.	N.A. GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.456

* DENOTES UNAVAILABLE DATA
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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: A-FRAME
REPORT PERIOD: FEBRUARY,1979

SOLAR/1010-79/02

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	0.079	71	0.022	N	0.002	N	0.275
2	0.133	72	0.039	O	0.003	O	0.295
3	0.094	70	0.023	T	0.002	T	0.246
4	0.116	69	0.035		0.002		0.299
5	0.047	65	0.007	A	0.001	A	0.142
6	*	*	*	P	*	P	*
7	0.038	71	0.005	P	0.001	P	0.144
8	*	*	*	L	*	L	*
9	0.050	71	0.012	I	0.002	I	0.235
10	*	*	*	C	*	C	*
11	0.037	67	0.006	A	0.001	A	0.164
12	0.070	67	0.015	B	0.002	B	0.213
13	0.081	66	0.019	L	0.002	L	0.238
14	*	*	*	E	*	E	*
15	*	*	*		*		*
16	0.034	69	0.006		0.002		0.185
17	*	*	*		*		*
18	0.028	68	0.004		0.001		0.151
19	0.031	68	0.007		0.002		0.232
20	0.052	70	0.012		0.001		0.239
21	*	*	*		*		*
22	0.077	73	0.021		0.002		0.272
23	0.110	71	0.034		0.002		0.308
24	0.067	70	0.003		0.001		0.051
25	*	*	*		*		*
26	0.099	72	0.028		0.002		0.284
27	0.066	72	0.017		0.002		0.259
28	0.155	72	0.054		0.003		0.346
SUM	2.052	-	0.519	N.A.	0.052	N.A.	-
AVG	0.073	70	0.019	N.A.	0.002	N.A.	0.253
NBS ID	C001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: A-FRAME
REPORT PERIOD: FEBRUARY,1979

SOLAR/1010-79/02

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	0.079	0.071	0.023	73	0.285
2	0.133	0.123	0.040	75	0.304
3	0.094	0.080	0.024	76	0.258
4	0.116	0.101	0.036	74	0.309
5	0.047	0.024	0.007	66	0.150
6	*	*	*	*	*
7	0.038	0.020	0.006	73	0.147
8	*	*	*	*	*
9	0.050	0.038	0.012	72	0.242
10	*	*	*	*	*
11	0.037	0.019	0.006	67	0.160
12	0.070	0.063	0.016	68	0.223
13	0.081	0.065	0.020	68	0.246
14	*	*	*	*	*
15	*	*	*	*	*
16	0.034	0.024	0.006	72	0.190
17	*	*	*	*	*
18	0.028	0.013	0.004	69	0.153
19	0.031	0.023	0.007	70	0.229
20	0.052	0.040	0.013	75	0.241
21	*	*	*	*	*
22	0.077	0.067	0.021	*	0.275
23	0.110	0.104	0.035	74	0.316
24	0.067	0.024	0.004	71	0.062
25	*	*	*	*	*
26	0.099	0.089	0.029	75	0.291
27	0.066	0.058	0.017	74	0.264
28	0.155	0.146	0.055	75	0.351
SUM	2.052	1.668	0.533	-	-
AVG	0.073	0.060	0.019	72	0.260
NESID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: A-FRAME
REPORT PERIOD: FEBRUARY,1979

SOLAR/1010-79/02

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR.OF LOAD PER CENT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	0.023	100	0.022	N	0.000	0.000	N	0.022	N	67	126	53
2	0.014	100	0.039	O	0.000	0.000	O	0.039	O	70	120	25
3	0.021	100	0.023	T	0.000	0.000	T	0.023	T	71	135	40
4	0.037	100	0.035		0.000	0.000		0.035		70	124	83
5	0.019	100	0.007	A	0.000	0.000	A	0.007	A	68	121	52
6	*	*	*	P	*	*	P	*	P	70	116	*
7	0.002	100	0.005	P	0.000	0.000	P	0.005	P	70	115	6
8	*	*	*	L	*	*	L	*	L	*	*	*
9	0.003	100	0.012	I	0.000	0.000	I	0.012	I	71	102	13
10	*	*	*	C	*	*	C	*	C	71	108	*
11	0.036	36	0.006	A	0.062	0.062	A	0.006	A	69	116	108
12	0.023	94	0.015	B	0.011	0.011	B	0.015	B	67	120	59
13	0.004	100	0.019	L	0.000	0.000	L	0.019	L	68	106	13
14	*	*	*	E	*	*	E	*	E	*	*	*
15	*	*	*		*	*		*		*	*	*
16	0.026	89	0.006		0.033	0.033		0.006		69	106	70
17	*	*	*		*	*		*		*	*	*
18	0.044	31	0.004		0.086	0.086		0.004		70	107	120
19	0.020	64	0.007		0.023	0.023		0.007		70	112	61
20	0.014	75	0.012		0.016	0.016		0.012		70	115	35
21	*	*	*		*	*		*		*	*	*
22	0.019	100	0.021		0.000	0.000		0.021		71	113	49
23	0.002	100	0.034		0.000	0.000		0.034		71	121	5
24	0.009	100	0.003		0.000	0.000		0.003		71	128	19
25	*	*	*		*	*		*		*	*	*
26	0.026	100	0.028		0.000	0.000		0.028		71	117	65
27	0.020	100	0.017		0.000	0.000		0.017		71	113	65
28	0.044	100	0.054		0.000	0.000		0.054		71	111	110
SUM	0.569	-	0.519	N.A.	0.323	0.323	N.A.	0.519	N.A.	-	-	1470
AVG	0.020	83	0.019	N.A.	0.012	0.012	N.A.	0.019	N.A.	70	116	52
NBS	Q302	N300	Q300	Q303	Q301	Q305	Q306	Q311	Q313	N305	N307	N308

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SCLAR HEATING AND CCCLING DEMCNSTRATICN PROGRAM

MONTHLY REPORT
ENVIRCNMENTAL SUMMARY

SITE: A-FRAME
REPCRT PERICC: FEBRUARY,1979

SCLAR/1010-79/02

DAY OF MCNTH	TCTAL INSOLATION BTU/SQ.FT	DIFFUSE INSCLATICN BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTICN DEGREES	WIND SPEED M.P.H.
1	1035	N	71	73	N	N	N
2	1733	C	72	75	O	O	O
3	1229	T	70	76	T	T	T
4	1518		69	74			
5	618	A	65	66	A	A	A
6	*	P	*	*	P	P	P
7	498	P	71	73	P	P	P
8	*	L	*	*	L	L	L
9	651	I	71	72	I	I	I
10	*	C	*	*	C	C	C
11	480	A	67	67	A	A	A
12	918	B	67	68	B	B	B
13	1061	L	66	68	L	L	L
14	*	E	*	*	E	E	E
15	*		*	*			
16	444		69	72			
17	*		*	*			
18	364		68	69			
19	406		68	70			
20	679		70	75			
21	*		*	*			
22	1002		73	*			
23	1433		71	74			
24	875		70	71			
25	*		*	*			
26	1295		72	75			
27	864		72	74			
28	2030		72	75			
SUM	26787	N.A.	-	-	-	-	-
AVG	957	N.A.	70	72	N.A.	N.A.	N.A.
NBS ID	Q001		N113			N115	N114

* DENCTES UNAVAILABLE DATA.
@ DENCTES NULL DATA.
N.A. DENCTES NCT APPLICABLE CATA.

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